to cause disproportionately high and adverse impacts to minority or low-income populations. This section uses the results of analyses from other disciplines and consideration of unique exposure pathways, sensitivities, and cultural practices to determine if disproportionately high and adverse impacts to human health or the environment of minority or low-income populations are likely to occur from repository performance confirmation, construction, operation and monitoring, and closure activities.

4.1.13.1 Methodology and Approach

DOE performs environmental justice analyses to identify whether any high and adverse impacts would fall disproportionately on minority and low-income populations. The potential for environmental justice concerns exists if the following could occur:

- *Disproportionately high and adverse human health effects:* Adverse health effects would be risks and rates of exposure that could result in latent cancer fatalities and other fatal or nonfatal adverse impacts to human health. *Disproportionately high and adverse human health effects* occur when the risk or rate for a minority or low-income population from exposure to a potentially large environmental hazard appreciably exceeds or is likely to appreciably exceed the risk to the general population and, where available, to another appropriate comparison group (DIRS 103162-CEQ 1997, all).

- *Disproportionately high and adverse environmental impacts to minority or low-income populations:* An adverse environmental impact is one that is unacceptable or above generally accepted norms. A disproportionately high impact is an impact (or the risk of an impact) to a low-income or minority community that significantly exceeds the corresponding impact to the larger community (DIRS 103162-CEQ 1997, all).

The approach to environmental justice analysis first brings together the results of analyses from different technical disciplines that focus on consequences to certain resources, such as air, land use, socioeconomics, air quality, noise, and cultural resources, that in turn could affect human health or the environment. On the basis of these analyses, DOE identified potential impacts on the general population. Second, based on available information, the approach assesses whether there are unique exposure pathways, sensitivities or cultural practices that would result in different impacts on minority or low-income populations. If potential impacts identified under either assessment would be high and adverse, the approach then compares the impacts on minority and low-income populations to those on the general population to determine whether any high and adverse impacts fall disproportionately on minority and low-income populations. In other words, if high and adverse impacts on a minority or low-income population would not appreciably exceed the same type of impacts on the general population, no disproportionately high and adverse impacts would be expected. In making these determinations, DOE considers geographical areas that contain high percentages of minority or low-income populations as reported by the Bureau of the Census. As discussed in Chapter 3, Section 3.1.13, DOE used 2000 Census data for minority populations and 1990 Census data for low-income populations as the best, readily available information that would allow identification of the minority and low-income populations.

The EIS definition of a minority population is in accordance with the basic racial and ethnic categories reported by the Bureau of the Census. A minority population is one in which the percent of the total population comprised of a racial or ethnic minority is meaningfully greater than the percent of such groups in the total population [for this EIS, a minority population is one in which the percent of the total population comprised of a racial or ethnic minority is 10 percentage points or more higher than the percent of such groups in the total population (DIRS 103162-CEQ 1997, all)]. Nevada had a minority population of 34.8 percent in 2000. For this EIS, therefore, one focus of the environmental justice analysis is the potential for construction, operation and monitoring, and closure of the proposed repository to have disproportionately high and adverse impacts on the populations in census tracts in the region of influence (principally in Clark, Nye, and Lincoln Counties) having a minority population of 44.8 percent or higher.

Nevada had a low-income population of 10 percent in 1990. Using the approach described in the preceding paragraph for minority populations, a low-income population is one in which 20 percent or more of the persons in a census block group live in poverty, as reported by the Bureau of the Census in accordance with Office of Management and Budget requirements (DIRS 148189-Bureau of the Census 1999, all). Therefore, the second focus of the environmental justice analysis for this EIS is the potential for construction, operation and monitoring, and closure of the proposed repository to have disproportionately high and adverse impacts on the populations in census block groups having a low-income population of 20 percent or higher.

In response to public comments, DOE has reevaluated available information to determine whether the Draft EIS overlooked any unique exposure pathways or unique resource uses that could create opportunities for disproportionately high and adverse impacts to minority and low-income populations, even though the impacts to the general population would not be high and adverse. Several unique pathways or resources were identified and analyzed, although none revealed a potential for disproportionately high and adverse impacts (see Section 4.1.13.2).

4.1.13.2 Preconstruction Testing and Performance Confirmation, Construction, Operation and Monitoring, and Closure

Cultural Resources

DOE has implemented a worker education program on the protection of these resources to limit direct impacts to cultural resources, especially inadvertent damage and illicit artifact collecting. If significant data recovery (artifact collection) were required during construction and operation, DOE would initiate additional consultations with Native American Tribes to determine appropriate involvement. Further, archaeological resources and potential data recovery would be managed and conducted through consultations with the State Historic Preservation Officer or the Advisory Council on Historic Preservation.

Public Health and Safety

The EIS analyses determined that the impacts that could occur to public health and safety would be small on the population as a whole for all phases of the Proposed Action, and that no subsections of the population, including minority or low-income populations, would receive disproportionate impacts. The analysis considered an area that included Timbisha Shoshone Trust lands near Scottys Junction, Nevada.

Because contamination of edible plants and animals would be unlikely from construction, operation and monitoring, and eventual closure of the repository, impacts to persons leading subsistence lifestyles would be unlikely. During the period of construction, operation and monitoring, and closure of the proposed repository, the only radionuclides expected to be released would be naturally occurring radon and radon decay products, and noble gases. Of these, only radon decay products have the potential to accumulate in the environment in the edible portions of wild animals that might live within the land withdrawal area and later be consumed. DOE estimated the potential health impacts from a subsistence diet based primarily on game taken from lands proximate to the repository exclusion areas. DOE calculated the consequences of a 100 kilograms per year (approximately 220 pounds per year or 10 to 11 ounces per day over a year) ingestion of animals that had hypothetically experienced radon uptake. For the peak year, DOE calculated a 0.4 millirem increase in dose, which would have no adverse health effects. DOE concluded that no disproportionately high and adverse health and safety impacts would be likely. DOE also reviewed data on the potential for radioactive uptake from consumption of piñon nuts (DIRS 156058-Fresquez et al. 2000, all). Because piñon pine nuts are produced irregularly in 7- to 10-year cycles and radionuclide concentrations are very low in piñon pine trees and their edible portions, DOE concluded there would be little potential health impact. There would be no disproportionately high and adverse health and safety impacts.

Land Use

Direct land-use impacts from the Proposed Action would be low on members of the public because of the existing restriction on site access for most affected areas. There are no communities with high percentages of minority or low-income populations within the region of influence (see Chapter 3, Table 3-1).

Air Quality

Impacts to air quality from the Proposed Action would be small. Furthermore, DOE would use best management practices for all activities, particularly ground-disturbing activities that could generate fugitive dust and construction activities that could produce vehicle emissions. The analysis considered an area that included Timbisha Shoshone Trust lands near Scottys Junction, Nevada.

Biological Resources and Soils

Impacts to biological resources and soils would be low to nonexistent. Consequences for any resources of importance to minority or low-income communities would be small.

Socioeconomics

Because of the large population and employment in the region of influence, socioeconomic impacts from repository construction and operation would be small. During the construction phase and the operation and monitoring phase, regional employment would increase less than 0.5 percent above the baseline level (see Section 4.1.6.2.1). Changes to the baseline regional population would not be greater than 0.5 percent through 2033. The Proposed Action would generate minimal impacts to employment and population. Potential socioeconomic impacts of all other economic parameters analyzed (Gross Regional Product, real disposable income, and expenditures by State and local governments) would be small.

Noise

Impacts to sensitive noise receptors from the Proposed Action would not be likely because no sensitive noise receptors live in the Yucca Mountain region. Furthermore, there are no low-income or minority communities adjacent to the site.

4.1.13.3 Environmental Justice Impact Analysis Results

This analysis uses information from Sections 4.1.1 through 4.1.12. Those sections address impacts from all active phases of the Proposed Action—construction, operation and monitoring, and closure. As noted above, DOE expects that the impacts of the Proposed Action would be small on the population as a whole. DOE has not identified any subsection of the population, including minority and low-income populations, that would receive disproportionate impacts, and no unique exposure pathways, sensitivities, or cultural practices that would expose minority or low-income populations to disproportionately high and adverse impacts. Accordingly, DOE has concluded that no disproportionately high and adverse impacts would result from the Proposed Action.

4.1.13.4 A Native American Perspective

Native American tribal governments have a special and unique legal and political relationship with the Government of the United States, as established by treaty, statute, legal precedent, and the U.S. Constitution. For this reason DOE will continue to consult with tribal governments and will continue to work with representatives of the Consolidated Group of Tribes and Organizations to ensure the consideration of tribal rights and concerns before making decisions or implementing programs that affect such tribes; to continue the protection of Native American cultural resources, sacred sites, and potential traditional cultural properties; and to implement any appropriate mitigation measures.

In reaching the conclusion that there would be no disproportionately high and adverse impacts on minorities or low-income populations, DOE acknowledges that people from many Native American tribes have used the area proposed for the repository as well as nearby lands (DIRS 102043-AIWS 1998, p. 2-1), that the lands around the site contain cultural, animal, and plant resources important to those tribes, and that the implementation of the Proposed Action would continue restrictions on free access to the repository site. DOE acknowledges that Native American people living in the Yucca Mountain vicinity have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the Proposed Action.

Native American people living in the Yucca Mountain vicinity hold views and beliefs about the relationship between the proposed repository and the surrounding region that they have expressed in *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement* (DIRS 102043-AIWS 1998, all). Concerning the approach to daily life, the authors of that document, who represent the Western Shoshone, Owens Valley Paiute and Shoshone, Southern Paiute, and other Native American organizations, state:

> *…we have the responsibility to protect with care and teach the young the relationship of the existence of a nondestructive life on Mother Earth. This belief is the foundation for our holistic view of the cultural resources, i.e., water, animals, plants, air, geology, sacred sites, traditional cultural properties, and artifacts. Everything is considered to be interrelated and dependent on each other to sustain existence (DIRS 102043-AIWS 1998, p. 2-9).*

The authors discuss the cultural significance of Yucca Mountain lands to Native American people:

> *American Indian people who belong to the CGTO (Consolidated Group of Tribes and Organizations) consider the YMP lands to be as central to their lives today as they have been since the creation of their people. The YMP lands are part of the holy lands of Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone people (DIRS 102043-AIWS 1998, p. 2-20).*

and:

> *The lack of an abundance of artifacts and archaeological remains does not infer that the site was not used historically or presently and considered an integral part of the cultural ecosystem and landscape (DIRS 102043-AIWS 1998, p. 2-10).*

The authors address the continuing denial of access to Yucca Mountain lands:

> *One of the most detrimental consequences to the survival of American Indian culture, religion, and society has been the denial of free access to their traditional lands and resources (DIRS 102043-AIWS 1998, p. 2-20).*

and:

> *No other people have experienced similar cultural survival impacts due to lack of free access to the YMP area (DIRS 102043-AIWS 1998, p. 2-20).*

The authors recognize that past restrictions on access have resulted in generally beneficial and protective effects for cultural resources, sacred sites, and potential traditional cultural properties (DIRS

102043-AIWS 1998, Section 3.1.1). However, the authors express concerns of Native American people regarding use of the repository:

> *The past, present, and future pollution of these holy lands constitutes both Environmental Justice and equity violations. No other people have had their holy lands impacted by YMP-related activities (DIRS 102043-AIWS 1998, p. 2-20).*

and:

> *Access to culturally significant spiritual places and use of animals, plants, water and lands may cease because Indian people's perception of health and spiritual risks will increase if a repository is constructed (DIRS 102043-AIWS 1998, p. 3-1).*

Even after closure and reclamation, the presence of the repository would represent an irreversible impact to traditional lands and other elements of the natural environment in the view of Native American people.

Regarding the transportation of spent nuclear fuel and high-level radioactive waste, the authors state:

> *…health risks and environmental effects resulting from the construction and operation of the proposed intermodal transfer facility (ITF) and the transportation of high-level waste and spent nuclear fuel is considered by Indian people to be disproportionately high. This is attributed primarily to the consumption patterns of Indian people who still use these plants and animals for food, medicine, and other related cultural or ceremonial purposes (DIRS 102043-AIWS 1998, p. 2-19).*

and:

> *The anticipated additional noise and interference associated with an ITF* [Intermodal Transfer Facility] *and increased transportation may disrupt important ceremonies that help the plants, animals, and other important cultural resources flourish, or may negatively impact the solitude that is needed for healing or praying (DIRS 102043-AIWS 1998, p. 2-19).*

DOE recognizes that it could not undertake disposal of spent nuclear fuel and high-level radioactive waste in a repository at Yucca Mountain without conflict with the viewpoint expressed in the American Indian Writers Subgroup document, but believes that, should the repository be designated, DOE would have the opportunity to engage in regular consultations with representatives of tribes in the region to identify further measures to protect cultural resources, thereby lessening the concern expressed by Native American people.

4.1.14 IMPACTS OF REPOSITORY OPERATING MODES

This section briefly describes and compares the short-term environmental impacts for the range of repository operating modes considered as part of the Proposed Action. This range includes the higher-temperature operating mode [where postclosure repository temperatures could be above the boiling point of water (96°C, or 205°F) and the lower-temperature operating mode [where postclosure repository temperatures would remain below 85°C (185°F)]. The lower-temperature operating mode also includes a range of operating characteristics, and differences noted below describe the largest potential differences among the operating modes.

In general, the EIS analyses found the lower-temperature operating mode would have higher environmental impacts than the higher-temperature operating mode. At least partly responsible for this is the fact that the duration of the lower-temperature operating mode (171 to 341 years) would be longer than the duration of the higher-temperature operating mode (115 years). Any time-dependent impacts, such as health and safety impacts to populations or energy or material usage, are typically higher for the longer duration lower-temperature operating mode. Overall, impacts would be small. Some areas of specific interest:

- Short-term health and safety impacts to the public would be small, with those of the lower-temperature operating mode 2 to 4 times greater than the higher-temperature operating mode.
- Short-term health and safety impacts to workers would be small, with those of the lower-temperature operating mode up to 60 to 70 percent greater than the higher-temperature operating mode.
- Short-term impacts for the land use, ambient air quality, surface water, groundwater, biological resources and soil, cultural resources, socioeconomics, repository accidents, noise, aesthetics, utilities, energy, materials, waste generation, and environmental justice would be small.

A more complete comparison of potential impacts is shown in Section 2.4 and Table 2-7.

4.1.15 IMPACTS FROM MANUFACTURING REPOSITORY COMPONENTS

This section discusses the potential environmental impacts from the manufacturing of components required by the Proposed Action to dispose of spent nuclear fuel and high-level radioactive waste permanently at a monitored geologic repository at Yucca Mountain. Repository components include disposal containers, emplacement pallets, drip shields, dry storage cask shells, and shipping casks. The solar panels required for the solar power electric generating facility are standard commercially available components that DOE could buy from several vendors. Therefore, there would be no offsite manufacturing environmental impacts specifically attributed to the solar panels. This analysis considers transportation overpacks that would provide radiation shielding in the same manner as a shipping cask but that DOE would use only in conjunction with disposable canisters and dual-purpose canisters to be shipping casks without baskets or other internal configurations.

4.1.15.1 Overview

DOE followed the overall approach and analytical methods used for the environmental evaluation and the baseline data directly from the *Department of the Navy Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel* (DIRS 101941-USN 1996, all). DOE's evaluation focuses on ways in which the manufacture of the repository components could affect environmental attributes and resources at a representative manufacturing site. It is not site-specific because more than one manufacturer probably would be required to meet the production schedule requirements for component delivery, and the location of the companies chosen to manufacture these components is not known. The companies and, therefore, the actual manufacturing sites would be determined by competitive bidding.

The analysis used a representative manufacturing site based on five facilities that produce casks, canisters, and related hardware for the management of spent nuclear fuel. The concept of a representative site was used in the Navy EIS (DIRS 101941-USN 1996, p. 4-1), and the representative site used in this analysis was defined in the same way, using the same five existing manufacturing facilities with the same attributes. The facilities used to define the representative site are in Westminster, Massachusetts; Greensboro, North Carolina; Akron, Ohio; York, Pennsylvania; and Chattanooga, Tennessee (DIRS 101941-USN 1996, p. 4-17). All of these facilities make components for firms with cask and canister designs approved by the Nuclear Regulatory Commission.

The analysis assumed that the manufacturing facilities and processes being used are similar to the facilities and processes that would produce disposal containers, emplacement pallets, drip shields, dry storage cask shells, and shipping casks for the Yucca Mountain Repository. Although these five facilities might not fabricate components from titanium (the material required for the drip shields), the fabrication processes of rolling plate, forming, and welding necessary to produce a drip shield are similar to the processes used to manufacture casks and canisters from other structural material. The estimates for manufacturing time and component cost account for the differences in processing titanium components (for example, welding), so the impacts of manufacturing titanium components could be estimated using the same methods as those used for standard nuclear-grade components. The analysis considered the manufacturing processes used at these facilities and the total number of components required to implement each packaging scenario. Manufacture of all components was assumed to occur at one representative site, but DOE recognizes that it probably would occur at more than one site. The assumption of one manufacturing site is conservative (that is, it tends to overestimate impacts) because it concentrates the potential impacts.

In addition, the analysis of offsite manufacturing evaluated the use of materials and the potential for impacts to material markets and supplies.

Section 4.1.15.3 describes the components to be manufactured offsite. Section 4.1.15.4 discusses pertinent information on environmental settings for air quality, health and safety, and socioeconomics. Section 4.1.15.5 describes environmental impacts on air quality, health and safety, socioeconomics, material use, waste generation, and environmental justice.

4.1.15.2 Components and Production Schedule

Table 4-45 lists the quantities of components analyzed for the higher- and lower-temperature operating modes for canistered and uncanistered packaging scenarios described in Chapter 2, Section 2.1.1. In general, the environmental impacts of offsite manufacturing are bounded by the uncanistered packaging scenario. The impacts of the canistered scenario are also presented to allow canistered and uncanistered comparisons. The only component with higher quantities under canistered scenarios would be rail shipping casks. Table 4-45 includes all repository components for naval spent nuclear fuel that would be emplaced in Yucca Mountain but does not include shipping casks for naval spent nuclear fuel. Shipping casks for naval spent nuclear fuel are owned and managed by the Navy. DIRS 101941-USN (1996, all) analyzed environmental impacts for production of naval spent nuclear fuel canisters and shipping casks. Because naval spent nuclear fuel waste packages represent less than 3 percent of the inventory to be emplaced in the repository, the production of naval spent nuclear fuel casks would add little to the impacts described in the following sections.

Table 4-45. Quantities of offsite-manufactured components for the Yucca Mountain Repository.[a]

		Operating mode/packaging scenario[b]			
		Higher-temperature		Lower-temperature	
Component	Description	UC	C	UC	C
Rail shipping casks or overpacks	Storage and shipment of SNF[c] and HLW[c]	0	92 or 120	0	92 or 120
Legal-weight truck shipping casks	Storage and shipment of uncanistered fuel	120	8	120	8
Disposal containers		11,300	11,300	11,300 - 16,900	11,300 - 16,900
Emplacement pallet	Support for emplaced waste package	11,300	11,300	11,300 - 16,900	11,300 - 16,900
Drip shields	Titanium cover for a waste package	10,500	10,500	11,300 - 15,900	11,300 - 15,900
Solar panels[d]	Photovoltaic solar panels–commercial units	27,000	27,000	27,000	27,000
Dry storage cask shells[e]	Metal shell structure of storage vault for aging	0	0	0 - 4,000	0 - 4,000

a. The number of containers is an approximation but is based on the best available estimates.
b. UC = uncanistered; C = canistered.
c. SNF = spent nuclear fuel; HLW = high-level radioactive waste.
d. Number of panels in use at any one time.
e. Necessary only for commercial spent nuclear fuel and only if DOE used surface aging as part of a lower-temperature operating mode.

As currently planned, all of the components listed in Table 4-45 except drip shields would be manufactured over 24 years to support emplacement in the repository. Manufacturing activity would build up during the first 5 years, then would remain nearly constant through the remainder of the 24-year period. The drip shields would not be needed until the closure of the repository; therefore, the analysis assumed manufacture and delivery of drip shields would not begin until nearly 76 to 300 years after the completion of emplacement. It would take approximately 10 years to manufacture drip shields. The solar power generating facility would be built over a 6-year period beginning in 2005 (DIRS 153882-Griffith 2001, p. 6).

The dry storage cask shells would be needed only if surface aging were to be used in conjunction with the lower-temperature operating mode. Because surface aging would occur in parallel with emplacement, the dry storage cask shells would be manufactured in the same 24-year period as the disposal containers, emplacement pallets, and shipping casks.

4.1.15.3 Components

Disposal Containers

The disposal container would be the final outside container used to package the spent nuclear fuel and high-level radioactive waste emplaced in the repository. The basic design calls for a cylindrical vessel with an outer layer of corrosion-resistant nickel-based alloy (Alloy-22) and an inner liner of stainless steel Type 316NG. The inner and outer lids would be stainless steel Type 316NG and Alloy-22, respectively. An additional Alloy-22 lid would be installed on the closure end. The bottom lids would be welded to the cylindrical body at the fabrication shop, and the top inner and outer lids would be welded in place after the placement of spent nuclear fuel or high-level radioactive waste in the container at the repository. About 10 different disposal container designs would be used for different types of spent nuclear fuel and high-level radioactive waste. The designs would vary in length from 3.6 to 6.1 meters (11.8 to 20 feet) and the outside diameters would range from 1.3 to 2.1 meters (4.3 to 6.6 feet). In addition, the internal configurations of the containers would be different to accommodate different uncanistered spent nuclear fuel configurations and a variety of spent nuclear fuel and high-level radioactive waste disposable canisters. The mass of an empty disposal container would range from about 19 to 33 metric tons (21 to 36 tons). If surface aging was used as part of the lower-temperature operating mode, containers used for aging are assumed to be stainless steel Type 316NG.

Casks for Rail and Legal-Weight Truck Shipments

DOE would use two basic kinds of shipping cask designs—rail and truck—to ship spent nuclear fuel and high-level radioactive waste to the repository. The design of a specific cask would be tailored to the type of material it would contain. For example, rail and truck casks that could be used to ship commercial spent nuclear fuel would be constructed of stainless- or carbon-steel plate materials formed into cylinders and assembled to form inner and outer cylinders (DIRS 101941-USN 1996, p. 4-3 and 4-4). A depleted uranium or lead liner would be installed between the stainless- or carbon-steel cylinders, and a vessel bottom with lead or depleted uranium between the inner and outer stainless- or carbon-steel plates would be welded to the cylinders. A support structure that could contain neutron-absorbing material would be welded into the inner liner, if required. A polypropylene sheath would be placed around the outside of the cylinder for neutron shielding. After spent nuclear fuel assemblies were inserted into the cask, a cover with lead or depleted uranium shielding would be bolted to the top of the cylinder to close and seal it. Transportation overpacks would be very similar in design and construction to shipping casks but would not have an internal support structure for the spent nuclear fuel because they would be used only for dual-purpose or disposable canisters.

For commercial spent nuclear fuel, casks and overpacks are typically 4.5 to 6 meters (15 to 20 feet) long and about 0.5 to 2 meters (1.6 to 6.6 feet) in diameter. These casks are designed to be horizontal when shipped. Empty truck casks typically weigh from 21 to 22 metric tons (about 23 to 24 tons). Empty rail casks (or overpacks) for commercial spent nuclear fuel typically weigh from 59 to 91 metric tons (65 tons to a little over 100 tons). The corresponding weights when loaded with spent nuclear fuel range between 22 and 24 metric tons (24 and 26 tons) for truck casks and between 64 and 110 metric tons (70 and 120 tons) for rail casks. For protection during shipment, large removable impact limiters of aluminum honeycomb or other crushable impact-absorbing material would be placed over the ends (DIRS 101837-JAI 1996, all).

Emplacement Pallets

The emplacement pallet would support the waste packages emplaced and allow end-to-end placement of waste packages to within 10 centimeters (4 inches) of each other. The emplacement pallet would be shorter than the waste package so it would not interfere with close placement. The pallets would be fabricated from Alloy-22 plates welded together to form a V-shaped top surface, which would accept all waste package diameters, and two Alloy-22 supports. Stainless steel Type 316L tubes would connect the two emplacement Alloy-22 supports. Two pallet overall lengths are specified for emplacement support of all waste package designs. The shorter emplacement pallet [2.5 meters (8 feet)] would be used for the waste package containing DOE spent nuclear fuel and high-level radioactive waste and the longer emplacement pallet [4.2 meters (14 feet)] would be used for all other waste package designs. The mass of a short pallet and a long pallet is 1.8 and 2.1 metric tons (2 and 2.2 tons), respectively.

Drip Shields

The drip shield would be a rigid structure designed to divert water away from the waste packages. The drip shield would be fabricated from titanium Grade 7 plates for the water diversion surface, titanium Grade 24 for the structural members, and Alloy-22 for the feet. The Alloy-22 feet would be mechanically attached to the titanium drip shield side plates, since the two materials cannot be welded together. For the higher-temperature operating mode and the lower-temperature operating modes with waste package spacing of less than 1.6 meters (5 feet), a continuous design drip shield would be used. The continuous design drip shield would be installed in sections, with one end designed to overlap and interlock with the opposite end of the previously emplaced drip shield section. The continuous drip shield section would be 6.1 meters (20 feet) long by 2.5 meters (8 feet) wide by 6.1 meters (20 feet) high with a mass of 4.2 metric tons (4.6 tons).

For the lower-temperature operating mode, as waste package spacing increased it might become economical to use a freestanding enclosed drip shield design (DIRS 152808-Skorska 2000, all). The freestanding drip shield would be designed in two lengths, one shorter version [3.9-meter (13-foot) length] for the waste package containing DOE spent nuclear fuel and high-level radioactive waste and one longer version [6.4-meter (20-foot) length] for all other waste package designs. The ends of these drip shields would be partially enclosed. The materials used for the freestanding drip shield design would be the same as for the continuous design drip shield. The mass of a short drip shield and a long drip shield is 3.1 metric tons (3.4 tons) and 4.55 metric tons (5 tons), respectively.

Dry Storage Cask Shells

The dry storage cask shell would be fabricated from carbon steel. The shell would be the portion of the concrete dry storage cask system (used only for surface aging under the lower-temperature operating mode) that would be manufactured offsite. Each shell, which includes a base structure, would be approximately 3.4 meters (11 feet) in diameter by 5.9 meters (19 feet) high and would be made from thick carbon steel plate. Carbon steel plate would be formed into a cylinder to form the shell and carbon plate material would be welded to the shell cylinder to form the base structure of the shell. The shell would weigh about 44 metric tons (49 tons).

4.1.15.4 Existing Environmental Settings at Manufacturing Facilities

Because there are facilities that could meet the projected manufacturing requirements, the assessment concluded that no new construction would be necessary and that there would be no change in land use for the offsite manufacture of repository components. Similarly, cultural, aesthetic, and scenic resources would remain unaffected. Ecological resources, including wetlands, would not be affected because existing facilities could accommodate the manufacture of repository components and new or expanded facilities would not be required. Some minor increases in noise, traffic, or utilities would be likely, but none of these increases would result in impacts on the local environment.

Water consumption and effluent discharge during the manufacture of components would be typical of a heavy manufacturing facility and would represent only a small change, if any, from existing rates. Similarly, effluent discharges would not increase enough to cause difficulty in complying with applicable local, state, and Federal regulatory limits, and would be unlikely to result in a discernible increase in pollutant activity.

Accordingly, the following paragraphs contain information on environmental settings for air quality, health and safety, and socioeconomics. Section 4.1.15.5 evaluates the environmental impacts to these resource areas for a representative site.

Air Quality

The analysis evaluated the ambient air quality status of the representative manufacturing location by examining the air quality of the areas in which the reference manufacturing facilities are located. The principal criteria pollutants for cask manufacturing facilities are ozone, carbon monoxide, and particulate matter (PM_{10}). Areas where ambient air quality standards are not exceeded, or where measurements have not been made, are considered to be in attainment. Areas where the air quality violates Federal or state regulations are in nonattainment and subject to more stringent regulations. Typical existing container and cask manufacturing facilities are in nonattainment areas for ozone and in attainment areas for carbon monoxide and particulate matter.

Because most of the existing typical manufacturing facilities are in nonattainment areas for ozone, the analysis assumed that the representative site would be in nonattainment for ozone and that ozone would be the criteria pollutant of interest. Volatile organic compounds and nitrous oxides are precursors for ozone and are indicators of likely ozone production. For the areas in which the reference manufacturing facilities are located, an average of 3,400 metric tons (approximately 3,800 tons) of volatile organic compounds and 39,000 metric tons (approximately 43,000 tons) of nitrous oxides were released to the environment in 1990 (DIRS 101941-USN 1996, p. 4-5).

Health and Safety

Data on the number of accidents and fatalities associated with cask and canister fabrication at the representative manufacturing location were based on national incidence rates for the relevant sector of the economy. In 1992, the occupational fatality rate for the sector that includes all manufacturing was 3 per 100,000 workers; the occupational illness and injury rate for fabricated plate work manufacturing in 1992 was 6.3 per 100 full-time workers (DIRS 101941-USN 1996, p. 4-5).

The manufacture of hardware for each of the operating modes and packaging scenarios would be likely to be in facilities that have had years of experience in rolling, shaping, and welding metal forms, and then fabricating large containment vessels similar to the required repository components for nuclear materials. Machining operations at these facilities would involve standard procedures using established metalworking equipment and techniques. Trained personnel familiar with the manufacture of large, multiwall, metal containment vessels would use the equipment necessary to fabricate such items. Because of this experience and training, DOE anticipates that the injury and illness rate would be equal to or lower than the industry rates.

Socioeconomics

Each of the five manufacturing facilities examined in this analysis is in a Metropolitan Statistical Area or a Primary Statistical Area, as defined by the U.S. Bureau of the Census. The counties comprising each statistical area define the affected socioeconomic environment for each facility. The populations of the affected environments associated with the five facilities ranged from about 373,000 to 1.2 million in 1998 (DIRS 156775-Bureau of the Census 2001, p. 33). In 1995, output (the value of goods and services produced in the five locations) ranged from $18 billion to $55 billion. The income (wages, salaries, and property income) ranged from $9 billion to $26 billion, area employment ranged from 245,000 to 670,000 workers in 1995, and plant employment ranged from 25 to 995 (DIRS 101941-USN 1996, p. 4-6). Based on averages of this information, the representative manufacturing location has a population of about 690,000 and the representative plant employs 480. Local output in the area is $30 billion, local income is $15 billion, and local employment is 390,000.

4.1.15.5 Environmental Impacts

As mentioned in Section 4.1.15.4, this evaluation considered only existing manufacturing facilities, so environmental impact analyses are limited to air quality, health and safety, waste generation, and socioeconomics. Impacts are presented for the higher-temperature operating mode and a range of impacts are presented for the lower-temperature operating mode. In addition, this section contains a discussion of environmental justice.

4.1.15.5.1 *Air Quality*

The analysis used the baseline data and methods developed in DIRS 101941-USN (1996, Section 4.3) to estimate air emissions from manufacturing sites for the production of repository components. Criteria pollutants and hazardous air pollutants were considered, and predicted emissions were compared with typical regional or county-wide emissions to determine potential impacts of the emissions on local air quality.

Potential emissions were evaluated for a representative manufacturing location using the ambient air quality characteristics of typical manufacturing facilities, as described in Section 4.1.15.4. The analysis assumed that the representative location used for this analysis would be in a nonattainment area for ozone and in attainment areas for carbon monoxide and particulate matter. Therefore, ozone was the only criteria pollutant analyzed. Ozone is not normally released directly to the atmosphere, but is produced in a complex reaction of precursor chemicals (volatile organic compounds and nitrous oxides) and sunlight. This section evaluates the emissions of these precursors.

The reference air emissions associated with the manufacture of repository components were developed using the emissions resulting from manufacturing similar components (DIRS 101941-USN 1996, p. 4-6) and were normalized based on the number of work hours required for the manufacturing process. The analysis prorated these reference emissions on a per-unit basis to calculate annual emissions at the reference manufacturing site, assuming emissions from similar activities would be proportional to the number of work hours in the manufacturing process. To provide reasonable estimates of emissions, the analysis assumed that the volatile organic compounds used as cleaning fluids would evaporate fully into the atmosphere as a result of the cleaning processes used in manufacturing. The estimates of emissions were based on the total number of repository components manufactured over a 10-year period for drip shields and a 24-year period for all other components.

Table 4-46 lists the estimated annual average and estimated total emissions from the manufacture of components at the representative facility for each packaging scenario. Estimated annual average emissions of volatile organic compounds would vary from 1.0 to 1.5 metric tons (approximately 1.1 to 1.5 tons) a year for the 24-year period and from 0.59 to 0.89 metric ton (approximately 0.65 to 0.98 ton) for the 10-year drip shield manufacturing period. Nitrous oxide emissions vary from 1.3 to 1.9 metric tons (approximately 1.4 to 1.8 tons) a year for the 24-year period and from 0.76 to 1.2 metric tons (approximately 0.79 to 1.2 tons) for the 10-year drip shield manufacturing period. Annual average emissions from component manufacturing under any of the scenarios would be less than 0.05 percent of

Table 4-46. Ozone-related air emissions (metric tons)[a] at the representative manufacturing location.

Compound		Measure	Operating mode/packaging scenario[b]		
			UC	DPC	UC/DPC/DISP
			HT	HT	LT[c]
Volatile organic compounds					
	24-year period[d]	Annual average	1.0	1.0	1.0 - 1.5
		24-year total	25	26	25 - 35
		Percent of *de minimis*[e]	11	12	11 - 16
	10-year period[f]	Annual average	0.59	0.59	0.65 - 0.89
		10-year total	5.9	5.9	6.5 - 8.9
		Percent of *de minimis*	6.5	6.5	7.1 - 9.8
Nitrogen oxides					
	24-year period	Annual average	1.3	1.4	1.3 - 1.9
		24-year total	32	33	32 - 46
		Percent of *de minimis*	15	15	15 - 21
	10-year period	Annual average	0.76	0.76	0.85 - 1.2
		10-year total	7.6	7.6	8.5 - 12
		Percent of *de minimis*	8.4	8.4	9.3 - 13

a. To convert metric tons to tons, multiply by 1.1023.
b. UC = uncanistered; DISP = disposable canister; DPC = *dual-purpose canister*; HT = higher-temperature operating mode; LT = lower-temperature operating mode.
c. For purposes of analysis, only the lower-temperature operating mode with aging is considered with the DISP packaging scenario.
d. The 24-year manufacturing period is for all components except drip shields and begins 2 years prior to emplacement.
e. *De minimis* level for an air quality region in extreme nonattainment for ozone is 9.1 metric tons per year of volatile organic compounds or nitrogen oxides (40 CFR 51.853).
f. The 10-year manufacturing period is for drip shields only and occurs at repository closure.

regional emissions of volatile organic compounds and 0.005 percent of regional emissions of nitrous oxides. Emissions from the manufacture of repository components would contain a relatively small amount of ozone precursors compared to other sources.

The examination assumed that the emissions of volatile organic compounds and nitrous oxides were new sources; these emissions were compared with emission threshold levels (emission levels below which conformity regulations do not apply). There are different categories of ozone nonattainment areas based on the sources of ozone and amount of air pollution in the region. The different categories have different emission threshold levels (40 CFR 51.853).

For an air quality region to be in extreme nonattainment for ozone (most restrictive levels), the emission threshold level for both volatile organic compounds and nitrous oxides is 9.1 metric tons (10 tons) per year. Table 4-46 also lists the percentage of volatile organic compounds and nitrous oxides from the manufacture of repository components in relation to the emission threshold level of an extreme ozone nonattainment area. Annual air emissions from the manufacture of repository components would vary depending on the operating mode and packaging scenario, with ranges of 6.5 to 16 percent and 8.4 to 21 percent of the emission threshold levels for volatile organic compounds and nitrous oxides, respectively. In all of the packaging scenarios, component manufacturing would not be likely to fall under the conformity regulations because the predicted emissions of volatile organic compounds and nitrous oxides would be well below (less than 21 percent of) the emission threshold level of 9.1 metric tons per year. However, DOE would ensure the implementation of the appropriate conformity determination processes and written documentation for each designated manufacturing facility.

States with nonattainment areas for ozone could place requirements on many stationary pollution sources to achieve attainment in the future. This could include a variety of controls on emissions of volatile organic compounds and nitrous oxides. Various options such as additional scrubbers, afterburners, or carbon filters would be available to control emissions of these compounds to comply with limitations.

4.1.15.5.2 *Health and Safety*

The analysis used data on the metal fabrication and welding industries from the Bureau of Labor Statistics to compile baseline occupational health and safety information for industries that fabricate steel and steel objects similar to the repository components (DIRS 101941-USN 1996, p. 4-8). The expected number of injuries and fatalities were computed by multiplying the number of work years by the injury and fatality rate for each occupation.

Table 4-47 lists the expected number of injuries and illnesses and fatalities for each scenario based on the work years required to produce the number of components. Injuries and illnesses would range from 580 to 840, depending on the operating mode and packaging scenario. Fatalities would be unlikely.

Table 4-47. Occupational injuries, illness, and fatalities at the representative manufacturing location.[a]

	Operating mode/packaging scenario		
	Higher-temperature		Lower-temperature[b]
Parameter	UC	DPC	UC/DPC/DISP[c]
Injuries and illnesses	580	600	600 - 840
Fatalities	0.28	0.28	0.28 - 0.40

a. Impacts from 24 years for manufacture for all components except drip shields and 10 years for manufacture of drip shields.
b. For purposes of analysis, only the lower-temperature operating mode with aging is considered with the DISP packaging scenario.
c. UC = uncanistered; DISP = disposable canister; DPC = dual-purpose canister.

The required number of repository components would not place unusual demands on existing manufacturing facilities. Thus, none of the scenarios would be likely to lead to a deterioration of worker safety and a resultant increase in accidents. In addition, nuclear-grade components are typically built to higher standards and with methods that are more proceduralized, both of which lead to improved worker safety.

4.1.15.5.3 *Socioeconomics*

The assessment of socioeconomic impacts from manufacturing activities involved three elements:

- Per-unit cost data for disposal containers, emplacement pallets, and drip shields (DIRS 150558-CRWMS M&O 2000, all) and per-unit cost of shipping casks (DIRS 104967-CRWMS M&O 1998, Table 12, pp. 17 and 18)
- Total number of components
- Economic data for the environmental setting for each facility to calculate the direct and secondary economic impacts of repository component manufacturing on the local economy (DIRS 103074-BEA 1992, all)
  - The local economy would be directly affected as manufacturing facilities purchased materials, services, and labor required for manufacturing.
  - The local economy would also experience secondary effects as industries and households supplying the industries that were directly affected adjusted their own production and spending behavior in response to increased production and income, thereby generating additional socioeconomic impacts.

Impacts were measured in terms of output (the value of goods and services produced), income (wages, salaries, and property income), and employment (number of jobs).

The socioeconomic analysis of manufacturing used state-level economic multipliers for fabricated metal products (DIRS 103074-BEA 1992, all). To perform the analysis, DOE obtained the product, income, and employment multipliers for the states where the five existing manufacturing facilities are located. (Multipliers account for the secondary effects on an area's economy in addition to providing direct effects on its economy). The multipliers were averaged to produce composite multipliers for a representative manufacturing location. The composite multipliers were used to analyze the impacts of each alternative. Table 4-48 lists the state-specific multipliers and the composite multipliers.

Table 4-48. Economic multipliers for fabricated metal products.[a]

State	Final demand multiplier ($)		Direct effect multiplier (number of jobs)
	Products	Earnings	
Massachusetts	1.8927	0.5555	2.2050
North Carolina	1.9145	0.5426	2.1544
Ohio	2.6019	0.7260	3.1064
Pennsylvania	2.5697	0.7194	2.8552
Tennessee	2.1379	0.6107	2.5314
Composite	2.2233	0.6308	2.5705

a. Source: DIRS 103158-Bureau of the Census (1992, all).

The analysis was limited to estimating the direct and secondary impacts of manufacturing activities. No assessment was made of the impacts of manufacturing activities on local jurisdictions. Such an analysis would include the estimation of impacts on county and municipal government and school district revenues and expenditures. Because the production of repository components probably would occur at existing facilities alongside existing product lines, a substantial population increase due to workers moving into the vicinity of the manufacturing sites in a given year under any scenario would be unlikely. Due to this lack of demographic impacts, meaningful change in the disposition of local government or school district revenues and expenditures would be unlikely. Because substantial population increases would not be likely, the analysis did not consider impacts on other areas of socioeconomic concern, such as housing and public services.

The analysis calculated average annual impacts for the manufacturing period of 10 years for drip shields and 24 years for all other components. The impacts of each packaging scenario were compared to the baseline at the representative location in 1995, with results expressed in millions of 2001 dollars. No attempt was made to forecast local economic growth or inflation rates for each representative location because of the non-site-specific nature of the analysis.

Table 4-49 lists the impacts of each operating mode and packaging scenario on output, income, and employment at the representative manufacturing location. The impacts include the percent of each scenario in relation to overall output, income, and employment in the economy.

Local Output

The average annual output impacts of each scenario would range from about $620 million to about $1,200 million (Table 4-48) depending on the operating mode and packaging scenario. Output generated from each scenario would increase total local output from between 1.8 percent and 2.4 percent, on average, over the 24-year manufacturing period, and from between 2.4 percent and 3.5 percent over the 10-year drip shield manufacturing period.

Table 4-49. Socioeconomic impacts for operating modes and packaging scenarios at the representative manufacturing location.

Flexible design/ packaging scenario[a]	Average annual output[b]		Average annual income		Average annual employment	
	$ (millions)	Percent impact[c]	$ (millions)	Percent impact	Person-years	Percent impact
UC						
HT 24-year period[d]	620	1.8	180	1.1	800	0.21
HT 10-year period[e]	810	2.4	230	1.4	460	0.12
DPC						
HT 24-year period	630	1.8	180	1.1	820	0.21
HT 10-year period	810	2.4	230	1.4	460	0.12
UC/DPC/DISP[f]						
LT 24-year period	620 - 790	1.8 - 2.3	180 - 220	1.1 - 1.3	800 - 1,100	0.21 - 0.29
LT 10-year period	1,000 - 1,200	2.9 - 3.5	290 - 350	1.7 - 2.1	510 - 690	0.13 - 0.18

a. UC = uncanistered; DISP = disposable canister; DPC = dual-purpose canister; HT = higher-temperature operating mode; LT = lower-temperature operating mode.
b. Annual output and income impacts are expressed as millions of 2001 dollars.
c. Percent impact refers to the percentage of the baseline data discussed in Section 4.1.15.4 for the representative site, escalated to 2001 dollars.
d. The 24-year manufacturing period is for all components except drip shields and begins two years prior to emplacement.
e. The 10-year manufacturing period is for drip shields only and occurs at repository closure.
f. For purposes of analysis, only the lower-temperature operating mode with aging is considered with the DISP packaging scenario.

Local Income

The average annual income impacts of each packaging scenario would range from about $180 million to about $350 million (Table 4-48) depending on the operating mode and packaging scenario. Income generated from each scenario would increase total local income between 1.1 percent and 1.3 percent over the 24-year manufacturing period and from between 1.4 percent and 2.1 percent over the 10-year drip shield manufacturing period.

Local Employment

The average annual employment impacts of each packaging scenario would range from about 460 to about 1,100 work years (Table 4-48), depending on the operating mode and packaging scenario. Employment generated from any of the scenarios would increase total local employment about 0.22 percent, on average, over the 24-year manufacturing period and about 0.14 percent, on average, over the 10-year drip shield manufacturing period.

4.1.15.5.4 *Impacts on Material Use*

To the extent available, DOE based the calculations of the quantities of materials it would use for the manufacture of each component on engineering specifications for each hardware component. This information was provided by the manufacturers of systems either designed or under licensing review (DIRS 101941-USN 1996, Sections 3.0 and 4.1.1; DIRS 150558-CRWMS M&O 2000, all; DIRS 102030-CRWMS M&O 1999, all), or from conceptual design specifications for technologies still in the planning stages (DIRS 101837-JAI 1996, all). Data on per-unit material quantities for each component were combined with information on the number of components to be manufactured for each operating mode and packaging scenario. In addition, the analysis assessed the impact of component manufacturing for each scenario on the total U.S. production (or availability in the United States, if not produced in this country) of each relevant input material. The results of the assessment are expressed in terms of percent impacts on total U.S. domestic production of most commodities.

Table 4-50 lists estimated total quantities of materials that DOE would need for each packaging scenario along with the annual average requirement for each material. For each scenario the largest material

Table 4-50. Material use (metric tons).[a]

Material	Basic material use per operating mode/packaging scenario[b]					
	Higher-temperature				Lower-temperature	
	UC		DPC		UC/DPC/DISP[c]	
	Total	Annual	Total	Annual	Total	Annual
Aluminum	2,600	110	2,600	110	90 - 2,600	4 - 110
Chromium[d]	52,000	2,200	52,000	2,200	52,000 - 63,000	2,200 - 2,600
Copper	36	1	73	3	36 - 140	1 - 6
Depleted uranium	880	37	88	4	88-1,400	4 - 60
Lead	430	18	3,300	140	430 - 3,300	18 - 140
Molybdenum[e]	14,000	600	14,000	600	14,000 - 17,000	600 - 700
Nickel[f]	82,000	3,400	83,000	3,500	83,000 - 100,000	3,500 - 4,200
Steel[g]	150,000	6,300	150,000	6,300	150,000 - 330,000	6,300 - 14,000
Titanium	43,000	4,300	43,000	4,300	54,000 - 65,000	5,400 - 6,500

a. To convert metric tons to tons, multiply by 1.1023.
b. UC = uncanistered; DISP = disposable canister; DPC = dual-purpose canister.
c. For purposes of analysis, only the lower-temperature operating mode with aging is considered with the disposable canister packaging scenario.
d. Chromium estimated as 18 percent of stainless steel and 22 percent of nickel base alloy.
e. Molybdenum estimated as 13.5 percent of nickel base alloy.
f. Nickel estimated as 58 percent of nickel base alloy and 14 percent of stainless steel.
g. Steel estimated as 100 percent of carbon steel and 52 percent of stainless steel.

requirement by weight would be steel, ranging from about 150,000 to about 330,000 metric tons (160,000 to 360,000 tons), depending on the operating mode and packaging scenario.

Table 4-51 compares the annual U.S. production capacity to the annual requirements for the materials each scenario would use. With the exception of chromium, nickel, and titanium, consumption for each scenario would be less than 1.5 percent of the annual U.S. production.

Table 4-51. Annual amount (metric tons)[a] of material required for manufacturing, expressed as a percent of annual U.S. domestic production.

Material	Production[d,e,f]	Basic material use per flexible design operating mode/packaging scenario[b]					
		Higher-temperature				Lower-temperature	
		UC		DPC		UC/DPC/DISP[c]	
		Annual	Percent	Annual	Percent	Annual (max)[g]	Percent
Aluminum	5,000,000	110	0.002	110	0.002	110	0.002
Chromium	104,000	2,200	2.1	2,200	2.1	2,600	2.5
Copper	1,900,000	1	0.0001	3	0.0002	6	0.0003
Depleted uranium	14,700	37	0.25	4	0.03	60	0.41
Lead	430,000	18	0.004	140	0.03	140	0.03
Molybdenum	57,000	600	1.05	600	1.1	700	1.2
Nickel	14,600	3,400	23	3,500	24	4,200	29
Steel	91,500,000	6,300	0.007	6,300	0.007	14,000	0.01
Titanium	22,000	4,300	20	4,300	20	6,500	30

a. To convert metric tons to tons, multiply by 1.1023.
b. UC = uncanistered; DISP = disposable canister; DPC = dual-purpose canister; HT = higher-temperature operating mode; LT = lower-temperature operating mode.
c. For purposes of analysis, only the lower-temperature operating mode with aging is considered with the disposable canister packaging scenario.
d. Source: DIRS 103156-Bureau of the Census (1997, Table 1155, p. 700, and Table 1244, p. 756).
e. Source for depleted uranium production: DIRS 101941-USN (1996, p. 4-10).
f. Source for titanium production: DIRS 152457-Gambogi (1999, Volume 1, Table 2, p. 80.7).
g. Maximum from range for lower-temperature operating modes is reported here.

Therefore, the use of aluminum, copper, lead, molybdenum, depleted uranium or steel would not produce a noteworthy increased demand and should not have a meaningful effect on the supply of these materials.

The annual requirement for chromium as a component in stainless-steel and high-nickel alloy ranges from about 2.12 percent to about 2.5 percent of the annual U.S. production, depending on the flexible design operating mode and packaging scenario. Most chromium, which is an important constituent of many types of stainless steel, is imported into the United States and is classified as a Federal Strategic and Critical Inventory material. For comparative purposes, the maximum total requirement of about 63,000 metric tons (69,000 tons) can be evaluated as a percentage of the 1994 strategic chromium inventory of 1.04 million metric tons (1.15 million tons) (DIRS 103156-Bureau of the Census 1997, Table 1159, p. 702). The total repository program need would be about 6 percent of the strategic inventory. With the strategic inventory to support the program demand, chromium use should not cause any market or supply impacts.

Annual nickel use as a component in stainless steel and corrosion-resistant high-nickel alloys appears, relatively, the most important in comparison to U.S. production. The magnitude of the comparison is the result of low U.S. production because the United States imports most of the nickel it uses. Although the annual U.S. production of nickel is only 14,600 metric tons (16,100 tons), the annual U.S. consumption is 158,000 metric tons (174,000 tons) (DIRS 103156-Bureau of the Census 1997, Table 1155, p. 700). This annual consumption is supported by a robust world production of 1.04 million metric tons (1.15 million tons) (DIRS 103156-Bureau of the Census 1997, Table 1158, p. 702). The maximum annual program need is a little less than 3 percent of the U.S. consumption and about 0.5 percent of world production. Canada is a major world supplier of nickel. DOE does not anticipate that the maximum program demand would affect the U.S. or world nickel markets.

The annual amount of depleted uranium used over 24 years would range from 0.25 percent to 0.41 percent of the total U.S. annual production. These requirements would be small. Given the limited alternative uses of this material and the large current inventory of surplus depleted uranium hexafluoride owned by DOE, such impacts should be considered to be positive (DIRS 101941-USN 1996, p. 4-10). Lead or steel could be substituted for depleted uranium for radiation shielding in some cases. If those materials were used for this purpose, the thickness of the substituted material would increase in inverse proportion to the ratio of the density of the substituted material to the density of depleted uranium. If lead or steel were used, the shielding thickness would increase by about 170 percent or 240 percent, respectively, resulting in a much larger container (DIRS 101941-USN 1996, p. 4-10).

The annual requirement for titanium for drip shields ranges from about 4,300 to 6,500 metric tons (4,740 to 7,165 tons), depending on the operating mode and packaging scenario. The magnitude of the comparison is the result of low U.S. production of the basic raw material, because the United States imports most of the titanium raw material. Although the annual U.S. production of titanium raw material is only 21,600 metric tons (23,810 tons), the annual U.S. capacity to produce titanium ingots is 78,200 metric tons (86,200 tons) (DIRS 152457-Gambogi 1999, p. 80.7). The maximum annual program need is a little over 8 percent of the current annual U.S. ingot production. Titanium is classified as a Federal Strategic and Critical Inventory material and is the ninth most common element in the Earth's crust (DIRS 107031-U.S. Bureau of Mines 1985, p. 859). Because the drip shields would not be needed until repository closure, there would be adequate time (over 100 years) to complete production of titanium raw material or to import additional raw material in advance of the need to reduce impact on markets.

4.1.15.5.5 *Impacts of Waste Generation*

The component materials used in the manufacture of repository components would be carbon steel, high-nickel alloy, stainless steel, aluminum, copper, and titanium with either depleted uranium or lead used for shielding. The manufacture of shielding would generate hazardous or low-level radioactive waste, depending on the material used. Other organic and inorganic chemical wastes generated by the manufacture of repository components and the amounts generated have also been identified.

Based on data in DIRS 101941-USN (1996, p. 4-13), the analysis estimated annual volumes and quantities of waste produced for each scenario per component manufactured at the representative site. The potential for impacts was evaluated in terms of existing and projected waste handling and disposal procedures and regulations. In addition to relevant state regulatory agencies, the Environmental Protection Agency and the Occupational Safety and Health Administration regulate the manufacturing facilities.

Manufacturing to support the different flexible design operating modes and packaging scenarios would produce liquid and solid wastes at the manufacturing locations. To control the volume and toxicity of these wastes, manufacturers would comply with existing regulations. Pollution prevention and reduction practices would be implemented. The analysis evaluated only waste created as a result of the manufacturing process to produce repository components from component materials. It did not consider the waste produced in mining, refining, and processing raw materials into component materials for distribution to the manufacturer. The analysis assumed that the component materials, or equivalent component materials produced from the same raw materials, would be available from supplier stock, which would be available without regard to the status of the Yucca Mountain project.

Liquid Waste

The liquid waste produced during manufacturing would consist of used lubricating and cutting oils from machining operations and the cooling of cutting equipment. This material is currently recycled for reuse. Ultrasonic weld testing would generate some unpotable water-containing glycerin. Water used for cooling and washing operations would be treated for release by filtration and *ion* exchange, which would remove contaminants and permit discharge of the treated water to the sanitary system.

Table 4-52 lists the estimated amounts of liquid waste generated by the shaping, machining, and welding of the components required for each scenario. The annual average amount of liquid waste generated would range from 4.1 to 6.4 metric tons (approximately 4.5 to 7.0 tons) per year during either the 24-year or 10-year manufacturing periods. The small quantities of waste produced during manufacturing would not exceed the capacities of the existing equipment for waste stream treatment at the manufacturing facility.

Table 4-52. Annual average waste generated (metric tons)[a] at the representative manufacturing location.

		Operating mode/packaging scenario[b]		
		Higher-temperature		Lower-temperature
Compound	Measure	UC	DPC	UC/DPC/DISP[c]
Liquid				
24-year period[d]	Annual average	4.3	4.3	4.3 - 6.4
10-year period[e]	Annual average	4.1	4.1	4.4 - 6.2
Solid				
24-year period[d]	Annual average	0.59	0.59	0.59 - 0.88
10-year period[e]	Annual average	0.57	0.57	0.61 - 0.86

a. To convert metric tons to tons, multiply by 1.1023.
b. UC = uncanistered; DISP = disposable canister; DPC = dual-purpose canister.
c. For purposes of analysis, only the lower-temperature operating mode with aging is considered with the DISP packaging scenario.
d. The 24-year manufacturing period is for all components except drip shields and begins two years prior to emplacement.
e. The 10-year manufacturing period is for drip shields only and occurs at repository closure.

Solid Waste

Table 4-52 lists the solid waste that manufacturing operations would generate. The annual average amount of solid waste would range from 0.57 to 0.88 metric ton (approximately 0.58 to 0.90 ton) per year during either the 24-year or the 10-year manufacturing periods. The primary waste constituents would be steel and components of steel including nickel, manganese, molybdenum, chromium, and copper. These chemicals could be added to existing steel product manufacturing waste streams for treatment and disposal or recycling.

The analysis assumed that depleted uranium to be incorporated in the components would be delivered to the manufacturing facility properly shaped to fit as shielding for a shipping cask. As a result, depleted uranium waste would not be generated or recycled at the representative manufacturing site and would not pose a threat to worker health and safety. Lead used for gamma shielding would be cast between stainless-steel components for the shipping casks. Although the production of a substantial quantity of lead waste under any of the packaging scenarios would be unlikely, such waste would be recycled.

4.1.15.5.6 *Environmental Justice*

The purpose of this environmental justice assessment is to determine if disproportionately high and adverse health or environmental impacts associated with the manufacture of repository components would affect minority or low-income populations, as outlined in Executive Order 12898 and the President's accompanying cover memorandum. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs and activities on minority and low-income populations. A disproportionately high impact would be an impact (or risk of an impact) in a minority or low-income community that exceeded the corresponding impact on the larger community to a meaningful degree. The analysis discussed below is the analysis used in DIRS 101941-USN (1996, Section 4.8), which was adapted to the manufacturing of components for the Yucca Mountain Repository.

The environmental justice assessment considered human health and environmental impacts from the examination of impacts on air quality, waste generation, and health and safety. The assessment used demographic data to provide information on the degree to which minority or low-income populations would be disproportionately affected. The evaluation identified as areas of concern those in which minority or low-income populations could suffer disproportionately high and adverse impacts.

This evaluation used a representative site based on five facilities that manufacture casks or canisters and related hardware for spent nuclear fuel.

To explore potential environmental justice concerns, this assessment examined the composition of populations living within approximately 16 kilometers (10 miles) of the five manufacturing facilities to identify the number of minority and low-income individuals in each area. The percentages of minority and low-income persons comprising the population of the states where the facilities are located were used as a reference. DOE selected this radius because it would capture the most broadly dispersed environmental consequences associated with the manufacturing activities, which would be impacts to air quality. The number of persons in each target group in the defined area was compared to the total population in the area to yield the proportion of minority and low-income persons within approximately 16 kilometers of each facility.

A geographic information system was used to define areas within approximately 16 kilometers (10 miles) of each facility. Linked to 1990 census data, this analytical tool enabled the identification of block groups within 16 kilometers. In cases where the 16-kilometer limit divided block groups, the system calculated the fraction of the total area of each group that was inside the prescribed distance. This fraction provided the basis for estimating the total population in the area as well as the minority and low-income components.

The analysis indicated that in one location the proportion of the minority population in the area associated with the manufacturing facility is higher than the proportion of the minority population in the state. The difference between the percentage of the minority population living inside the 16-kilometer (10-mile) radius and the state is 1.5 percent (DIRS 101941-USN 1996, p. 4-18). DOE anticipates very small impacts for the total population from manufacturing activities associated with all the scenarios, so there would be no disproportionately high and adverse impacts to the minority population near this facility.

In addition, the percentage of the total population that consists of low-income families living within about 16 kilometers (10 miles) of a manufacturing facility would exceed that of the associated state in one instance. The difference in this case was 0.9 percent (DIRS 101941-USN 1996, p. 4-18). DOE anticipates very small impacts to individuals and to the total population, and no special circumstances would cause disproportionately high and adverse impacts to the low-income population living near the facility.

The EIS analysis determined that only small human health and environmental impacts would occur from the manufacture of repository components. Disproportionately high and adverse impacts to minority or low-income populations similarly would be unlikely from these activities.

4.2 Short-Term Environmental Impacts from the Implementation of a Retrieval Contingency or Receipt Prior to the Start of Emplacement

4.2.1 IMPACTS FROM RETRIEVAL CONTINGENCY

Section 122 of the Nuclear Waste Policy Act requires DOE to maintain the ability to retrieve emplaced waste for an appropriate period after the start of emplacement. Nuclear Regulatory Commission regulations at 10 CFR 63.111(e) specify a retrieval period of at least 50 years. Because of this requirement, the EIS analyzed the impacts of retrieval. Although DOE does not anticipate retrieval and it is not part of the Proposed Action, DOE would maintain the ability to retrieve the waste for at least 100 years and possibly for as long as 324 years in the event of a decision to retrieve the waste either to protect the public health and safety or the environment or to recover resources from spent nuclear fuel. Some of the impacts that could occur during retrieval have been addressed in the Proposed Action under the lower-temperature operating mode with surface aging. This operating mode would include surface aging of up to two-thirds of the commercial spent nuclear fuel over a 50-year operations period (Chapter 2, Section 2.1.1.2.2). This aging facility could be used to store a portion of any spent nuclear fuel or high-level radioactive waste that would be retrieved.

This EIS evaluates retrieval as a contingency action and describes potential impacts if it were to occur. The analysis in this EIS assumes that under this contingency DOE would retrieve all the waste and would place it on a surface storage pad pending future decisions about its ultimate disposition. Storage of spent nuclear fuel and high-level radioactive waste on the surface would be in compliance with applicable regulations.

4.2.1.1 Retrieval Activities

If there was a decision to retrieve spent nuclear fuel and high-level radioactive waste from the repository, DOE would move the waste packages from the emplacement drifts to the surface. Operations in the subsurface facilities to remove the waste packages would be the reverse of emplacement operations and would use the same types of equipment (see Chapter 2, Section 2.1.2.2).